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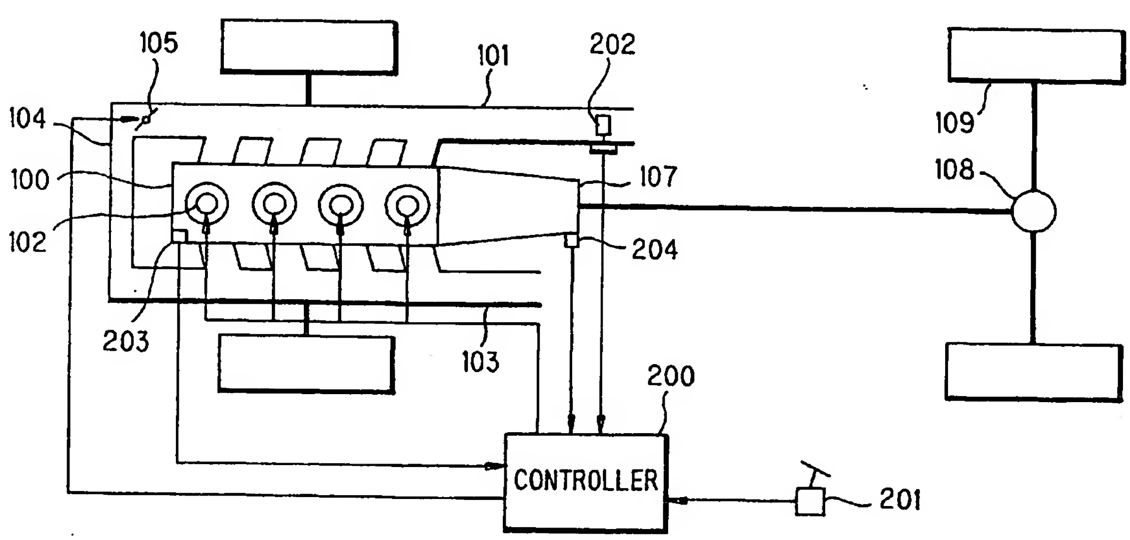
(54) Drive force controller of a diesel engine vehicle

(57) A first target drive force is computed based on the operation amount of an accelerator pedal, and dynamic delay processing is applied to the first target drive force to calculate a second target drive force. A target engine fresh air intake amount is computed from the first target drive force, the speed ratio and the engine rotation speed, and the fresh air intake amount of the engine is controlled to this target fresh air intake amount. The engine torque is computed and controlled based on the second target drive force, the speed ratio, the fresh air intake amount and the engine rotation speed.

FIG. 1



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amount should be increased as rapidly as possible.

[0012] In this case, due to the response delay of the target fresh air intake amount, the engine torque response will be impaired.

[0013] It is therefore an object of this invention to improve the engine torque response and improve drivability.

[0014] In order to achieve above the object the invention provides a drive force controller for a vehicle provided with a diesel engine and a transmission, the transmission changes an output rotation of the engine. The controller comprises a sensor which detects an accelerator pedal operation amount of the engine, a sensor which detects a fresh air amount drawn in by the engine, a sensor which detects an engine rotation speed, a sensor which detects a speed ratio of the transmission, and a controller functioning to calculate a first target drive force based on the operation amount of the accelerator pedal, apply dynamic delay processing to the first target drive force to calculate a second target drive force, calculate a target engine fresh air intake amount from the first target drive force, the speed ratio and the engine rotation speed, control the fresh air intake amount of the engine to this target fresh air intake amount, control a torque of the engine based on the second target drive force, the speed ratio, the fresh air intake amount and the engine rotation speed.

[0015] The details as well as other features and advantages of the invention are set forth in the remainder of the specification and are shown in the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0016] Fig. 1 is a system diagram of a vehicle according to a first embodiment of this invention.

[0017] Fig. 2 is a block diagram of drive force control in this system.

[0018] Fig. 3 is a block diagram of an engine torque control means.

[0019] Fig. 4 is a block diagram of a target intake fresh air amount setting means.

[0020] Fig. 5 is a map which sets a first target drive force.

[0021] Fig. 6 is a map which sets a first target fuel injection amount.

[0022] Fig. 7 is a map which sets a maximum fuel injection amount.

[0023] Fig. 8 is a map which sets a second target fuel injection amount.

[0024] Fig. 9 is a map which sets a target fresh air intake amount.

[0025] Fig. 10 is a diagram showing a table which sets an EGR valve opening.

[0026] Fig. 11 is a drive force control block diagram showing a second embodiment of this invention.

[0027] Fig. 12 is a block diagram of a means which sets a target EGR rate.

[0028] Fig. 13 is a map which sets the target EGR rate.

[0029] Fig. 14 is a diagram showing a table which sets the EGR valve opening.

[0030] Fig. 15 is a system diagram of a vehicle according to a third embodiment of this invention.

[0031] Fig. 16 is a drive force control block diagram in this system.

[0032] Fig. 17 is a block diagram of a means which sets a target supercharging pressure.

[0033] Fig. 18 is a map which sets the target supercharging pressure.

[0034] Fig. 19 is a diagram showing a table which sets the supercharger nozzle opening.

[0035] Fig. 20 is a diagram describing the effectiveness of this invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0036] Firstly, a first embodiment of this invention will be described.

[0037] Fig. 1 schematically shows the construction of the vehicle.

[0038] A diesel engine 100 mounted to a vehicle draws in fresh air (air) into a cylinder via an intake passage 101, and fuel is injected into the cylinder from an injector 102..The fuel is burnt by compression ignition, and the exhaust gas after combustion is discharged from an exhaust passage 103.

[0039] Part of this exhaust gas is recirculated into the intake passage 101 via an EGR (exhaust gas recirculation) passage 104 connected to the middle of the exhaust passage 103, and is introduced to the cylinder as EGR gas.

[0040] An EGR valve 105 is interposed in the EGR passage 104, and the exhaust gas recirculation rate is controlled by controlling the opening of this EGR valve 105. This also results in the control of the fresh air amount drawn in into the cylinder.

[0041] A continuously variable transmission (hereafter referred to as CVT) 107 is provided on the output side of this engine 100, and the output of the CVT107 is transmitted to a drive wheel 109 via a final reduction gear 108.

[0042] A controller 200 for drive force control is provided to control the CVT107 and the engine 100. This drive force control realizes a target drive force computed based on a running condition such as accelerator pedal operating amount, by controlling the engine torque and CVT speed ratio.

[0043] The controller 200 controls the fuel injection amount injected from the aforesaid injector 102, and the opening

[0058] Based on the next equation (5) which is a discrete representation of equation (4), the fresh air amount ***Qcw*** drawn in by the cylinder is calculated.

$$Qcw=\{(\Delta t/2\tau w)\cdot[Qw+z^{-1}Qw]+(1-\Delta t/2\tau w)\cdot z^{-1}Qcw\}\times(\Delta t/2\tau w+1)^{-1} \qquad (5)$$

where, in equations (4) and (5),

Qcw = cylinder fresh air intake amount [mg/st]
Qw = collector fresh air intake amount [mg/st]
τ ***w*** = parameter [sec] of the dynamic characteristics of the collector
Δ ***t*** = sampling time [sec]

[0059] Here, even if τ ***w*** is given as a constant, it may be changed according to the running state.
[0060] Δ ***t*** is given as a constant.
[0061] The engine speed detection means 5 detects the engine rotation speed by the engine rotation sensor 203.
[0062] The engine torque control means 6 controls the engine torque based on the second target drive force ***tFd2***, the aforesaid speed ratio, the aforesaid fresh air intake amount and the aforesaid engine rotation speed.
[0063] Here, the engine torque control means 6, as shown in Fig.6, comprises a first target engine torque setting means 6-1, first target fuel injection amount setting means 6-2, maximum fuel injection amount setting means 6-3, command fuel injection amount setting means 6-4, and fuel injection amount control means 6-5.
[0064] From the aforesaid equation (1), the aforesaid target engine torque setting means 6-1 first calculates the first target engine torque ***tTe1*** as the engine torque required to realize the second target drive force ***tFd2*** from the second target drive force and the speed ratio, for example from the following equation (6). This equation is deduced from equation (1) which calculates the drive force from the engine torque and speed ratio.

$$tTe1=(tFd2\times Rtire)/(G\times Gf) \qquad (6)$$

where, in equation (6),

tTe1 = first target engine torque [**Nm**]
tFd2 =[2] second target drive force [**N**]
Rtire = Drive wheel effective radius [**m**]
G = speed ratio of CVT
Gf = reduction ratio of final reduction gear.

Here, **Rtire** and ***Gf*** are given as constants.
[0065] Next, the first target fuel injection amount setting means 6-2 sets the first target fuel injection amount ***tQf1*** from the first target engine torque tTe1 and engine rotation speed.
[0066] The relation between the first target engine torque, engine rotation speed and the first target fuel injection amount is prepared beforehand as a map. An example of the map which sets the first target fuel injection amount is shown in Fig. 6. This map is found by experiment etc. as a characteristic of the engine torque relative to the engine rotation speed and fuel injection amount.
[0067] The maximum fuel injection amount setting means 6-3 sets a maximum fuel injection amount ***Qf-max*** as a ceiling value of the fuel injection amount from the fresh air intake amount and engine rotation speed based on a limit on the rich side of the excess air rate.
[0068] The relation between the fresh air intake amount, engine rotation speed and maximum fuel injection amount is prepared beforehand as a map. An example of the map which sets the maximum fuel injection amount is shown in Fig. 7. This map may be found from the excess air rate corresponding to a smoke generation amount tolerance level relative to the engine rotation speed. Specifically, numerical values of the map lattice axes are substituted for the fresh air intake amount and engine rotation speed on the right-hand side of equation (7) shown below, and the maximum fuel injection amount equivalent to this lattice is calculated.

$$Qf\text{-}max=Qcw/(\lambda\ min\ (Ne)\times k) \qquad (7)$$

is shown in Fig. 8, and the map settings are identical values to those of Fig. 6. The second target fuel injection amount is not a target value of the actual fuel injection amount, but is calculated as a parameter for setting the target fresh air intake amount.

[0080] The target fresh air intake amount setting means 7-3 sets a target intake fresh air amount from the second target fuel injection amount and engine rotation speed. The relation between the second target fuel injection amount, engine rotation speed and target fresh air intake amount is prepared beforehand as a map. An example of the map which sets the target fresh air intake amount is shown in Fig. 9.

[0081] The target fresh air intake amount may be set from the second target engine torque and engine rotation speed. In this case, the second target fuel injection amount setting means 7-2 is unnecessary.

[0082] Again, in Fig. 2, the intake fresh air amount control means 8 controls the opening of the EGR valve 105 so that the actual fresh air intake follows the target intake fresh air amount. The characteristics of the EGR valve opening relative to the target fresh air amount are shown in Fig. 10. If the opening of the EGR valve 105 is made small, the exhaust gas recirculation amount will become less, and the fresh air intake amount will increase.

[0083] Therefore, in this first embodiment, dynamic delay processing is performed on the first target drive force to set the second target drive force. Although the engine torque no longer exceeds an upper limit level even during acceleration, it is necessary to make the fresh air intake amount increase promptly within the limits of the upper limit level of engine torque during such an acceleration. This is because the response of the engine torque to the increase in fuel injection amount increases, the larger the excess air rate. The target fresh air intake amount is set based on the first target drive force and the speed ratio of the CVT107, and does not contain dynamic delay processing here. Therefore, the response of the increase in the fresh air intake amount is accelerated, and the engine torque required for acceleration promptly increases. The fresh air intake amount can also be increased by making the opening of the EGR valve 105 small.

[0084] Next, a second embodiment of this invention will be described.

[0085] The system construction of the vehicle in the case of the second embodiment is the same as that of the first embodiment (Fig. 1).

[0086] Fig. 11 is a block diagram of the drive force controller in the case of the second embodiment.

[0087] This drive force controller comprises a first target drive force setting means 1, second target drive force setting means 2, speed ratio detection means 3, fresh air intake amount detection means 4, engine speed detection means 5, engine torque control means 6, target EGR rate setting means 9, and EGR rate control means 10. The detailed construction of the target EGR rate setting means 9 is shown in Fig. 12.

[0088] The first target drive force setting means 1, second target drive force setting means 2, speed ratio detection means 3, fresh air intake amount detection means 4, engine speed detection means 5 and engine torque control means 6 are identical to what was described in the first embodiment shown in Fig. 2 and Fig. 3. The difference from the first embodiment is that the target intake fresh air amount setting means 7 and the fresh air intake amount control means 8 are replaced by the target EGR rate setting means 9 and the EGR rate control means 10.

[0089] In the second embodiment, regarding control of the fresh air intake amount, a target EGR rate is set instead of the target fresh air intake amount, and the intake fresh air intake amount is controlled indirectly. The purpose of the invention is the same as that of the first embodiment, i.e., to enhance the response of the fresh air intake amount relative to an accelerator pedal operation, and thereby improve engine torque.controllability and drivability.

[0090] Hereafter, the target EGR rate setting means 9 and the EGR rate control means 10 will mainly be described. The target EGR rate setting means 9 sets the target EGR rate by an algebraic operation which does not involve dynamic delay processing from first target drive force, the speed ratio and the engine rotation speed.

[0091] The target EGR rate setting means 9 comprises a second target engine torque setting means 7-1, second target fuel injection amount setting means 7-2 and target intake fresh air amount setting means 9-3, as shown in Fig. 12. The second target engine torque setting means 7-1 and the second target fuel injection amount setting means 7-2 are identical to what was described in Fig. 4.

[0092] A different point from Fig. 4 is that the target intake fresh air amount setting means 7-3 is replaced by a target EGR rate setting means 9-3.

[0093] The target EGR rate setting means 9-3 sets the target EGR rate from the second target fuel injection amount and engine rotation speed.

[0094] The relation between the second target fuel injection amount, engine rotation speed and target EGR rate is prepared beforehand as a map. An example of a map which sets this target EGR rate is shown in Fig. 13.

[0095] However, the target EGR rate can also be set from the second target engine torque and engine rotation speed. In this case, the second target fuel injection amount setting means 7-2 becomes unnecessary.

[0096] The EGR rate control means 10 controls the opening of the EGR valve 105 so that the actual EGR rate follows the target EGR rate. The characteristics of the EGR valve opening relative to the target EGR rate are shown in Fig. 14.

[0097] Therefore, according to this second embodiment, as the EGR rate for determining an EGR amount having a correlation with the fresh air intake amount is computed without including dynamic response processing, the intake air

engine torque determined by the maximum fuel injection amount can be made more rapid. Consequently, compared with the prior art, the restriction on the target engine torque (equivalent to the first target engine torque in this invention) decreases, and the ability to follow the target value of drive force improves as shown by the second target engine torque.

[0120] The entire contents of Japanese Patent Application 2000-331185(filed October 30, 2000) is incorporated herein by reference.

[0121] This invention is not limited to the above embodiments, various modifications being possible by those skilled in the art within the scope of the appended claims.

Claims

1. A drive force controller for a vehicle provided with a diesel engine(100) and a transmission(107), the transmission changes an output rotation of the engine, the controller comprising:

    a sensor(201) which detects an accelerator pedal operation amount of the engine,
    a sensor(202) which detects a fresh air amount drawn in by the engine,
    a sensor(203) which detects an engine rotation speed,
    a sensor(204) which detects a speed ratio of the transmission, and
    a controller(200) functioning to:

        calculate a first target drive force based on the operation amount of the accelerator pedal,
        apply dynamic delay processing to the first target drive force to calculate a second target drive force,
        calculate a target engine fresh air intake amount from the first target drive force, the speed ratio and the engine rotation speed,
        control the fresh air intake amount of the engine to this target fresh air intake amount,
        control a torque of the engine based on the second target drive force, the speed ratio, the fresh air intake amount and the engine rotation speed.

2. The drive force controller as defined in Claim 1, wherein:

    the controller(200) functions for controlling the engine torque to:

        compute a first target engine torque from the second target drive force and the speed ratio,
        compute a first target fuel injection amount from the first target engine torque and the engine rotation speed,
        compute a maximum fuel injection amount as an upper limit of the fuel injection amount based on a limit on the rich side of the air excess factor from the fresh air intake amount and engine rotation speed,
        compute a command value of the fuel injection amount by limiting the first target fuel injection amount to the maximum fuel injection amount, and
        control the fuel injection amount according to the command fuel injection amount.

3. The drive force controller as defined in Claim 1, wherein:

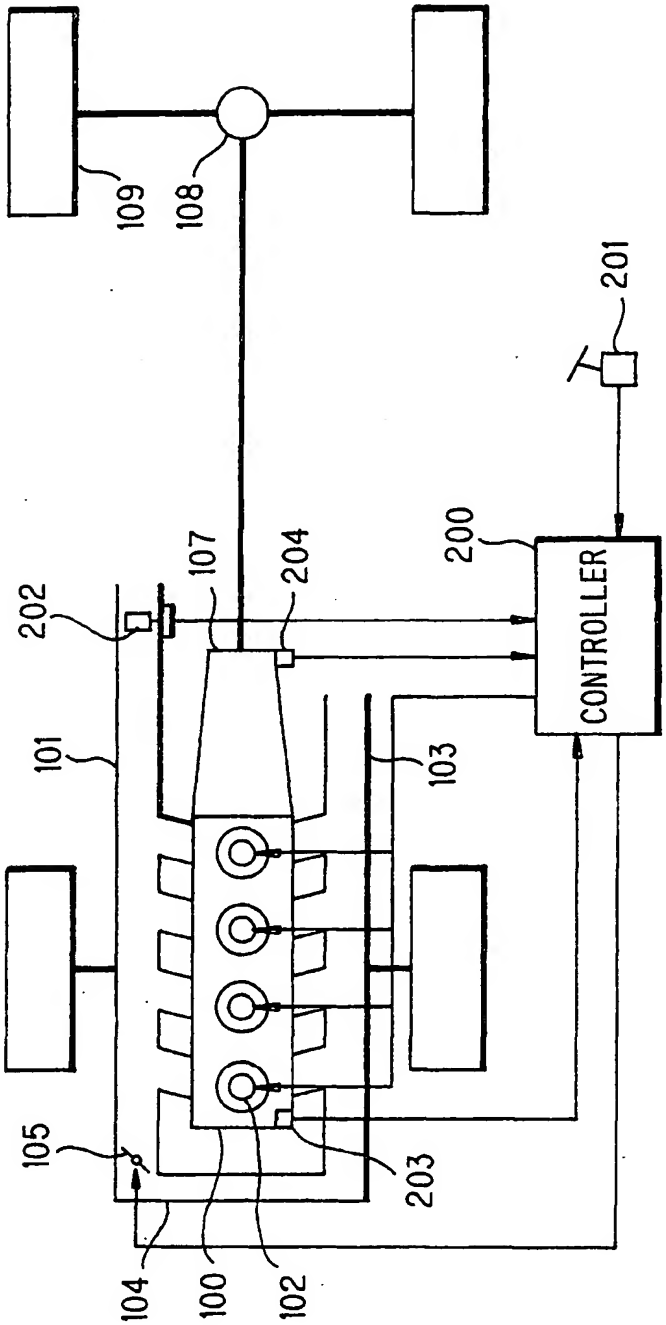
    the controller(200) functions for computing the target fresh air intake amount to:

        compute a second target engine torque from the first target drive force and the speed ratio,
        compute a second target fuel injection amount from the second target engine torque and the engine rotation speed, and
        compute the target fresh air intake amount from the second target fuel injection amount and the engine rotation speed.

4. A drive force controller for a vehicle provided with a diesel engine(100), and a transmission(107), the transmission changes an output rotation of the engine, the controller comprising:

    a sensor(201) which detects an accelerator pedal operation amount of the engine,
    a sensor(202) which detects a fresh air amount drawn in by the engine,
    a sensor(203) which detects an engine rotation speed,
    a sensor(204) which detects a speed ratio of the transmission,

FIG. 1



CONTROLLER
200
201
202
204
107
108
109
101
103
105
203
104
100
102

FIG. 3

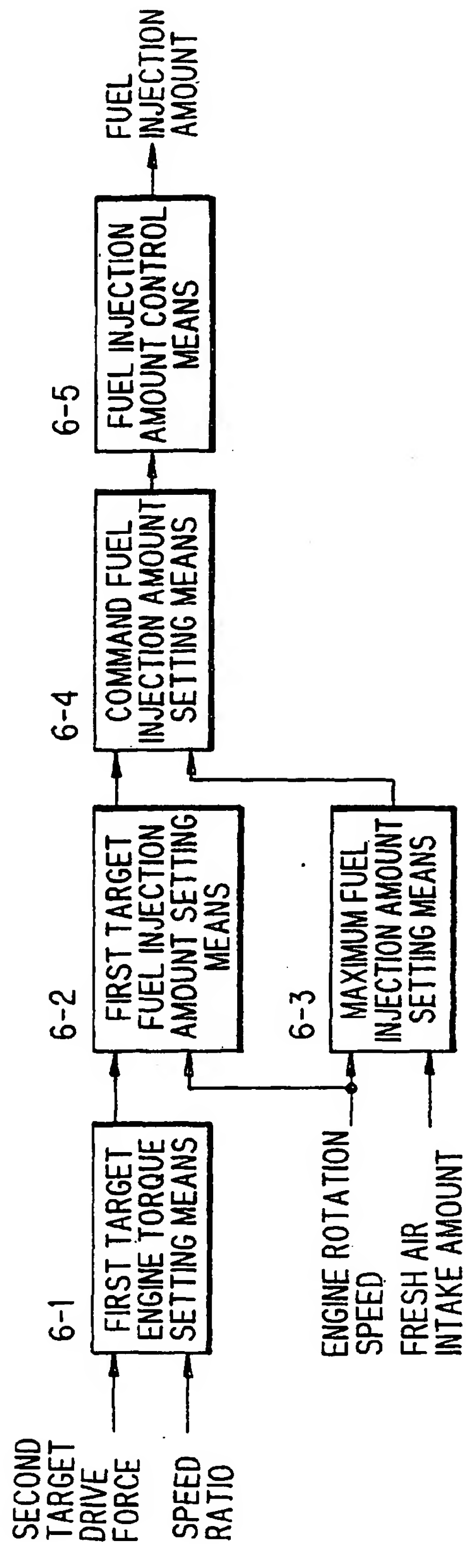

SECOND TARGET DRIVE FORCE
SPEED RATIO
6-1
FIRST TARGET ENGINE TORQUE SETTING MEANS
6-2
FIRST TARGET FUEL INJECTION AMOUNT SETTING MEANS
6-3
MAXIMUM FUEL INJECTION AMOUNT SETTING MEANS
ENGINE ROTATION SPEED
FRESH AIR INTAKE AMOUNT
6-4
COMMAND FUEL INJECTION AMOUNT SETTING MEANS
6-5
FUEL INJECTION AMOUNT CONTROL MEANS
FUEL INJECTION AMOUNT

FIG.5

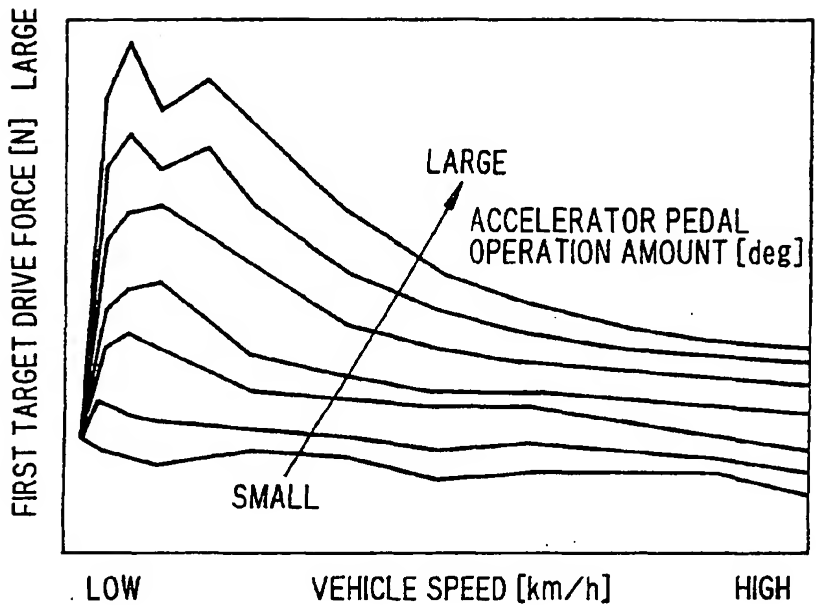

FIRST TARGET DRIVE FORCE [N]
LARGE
LARGE
ACCELERATOR PEDAL
OPERATION AMOUNT [deg]
SMALL
LOW
VEHICLE SPEED [km/h]
HIGH

FIG.6

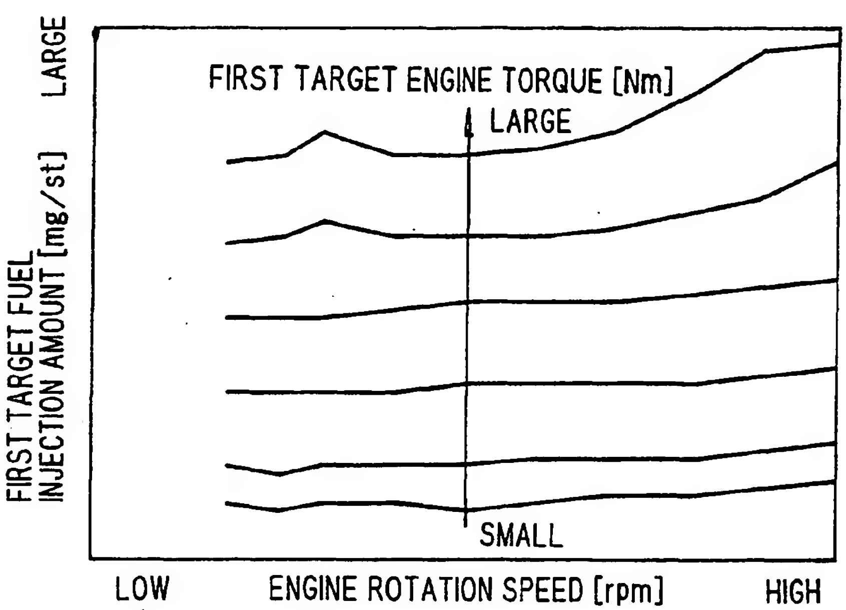

FIRST TARGET FUEL
INJECTION AMOUNT [mg/st]
LARGE
FIRST TARGET ENGINE TORQUE [Nm]
LARGE
SMALL
LOW
ENGINE ROTATION SPEED [rpm]
HIGH

FIG.9

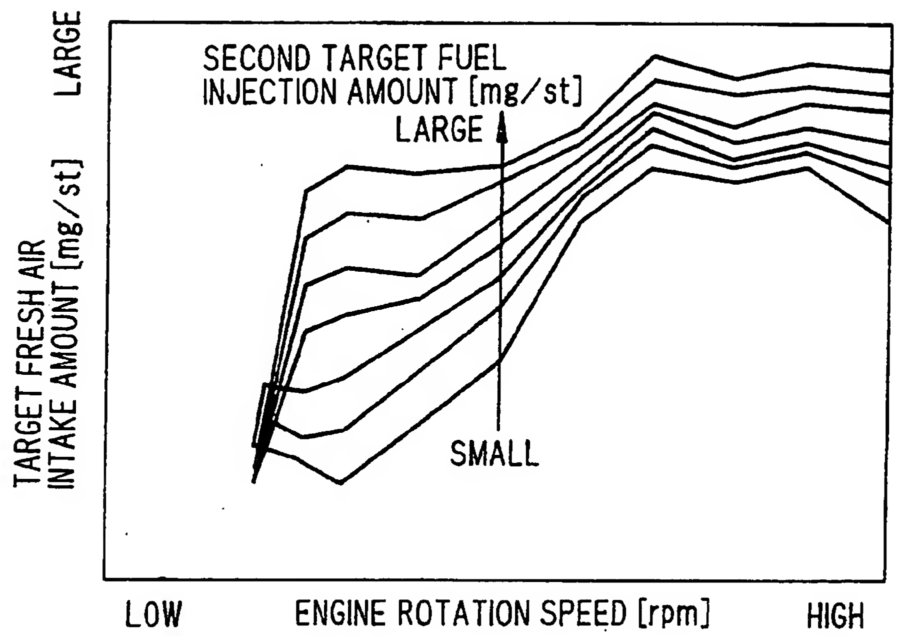

TARGET FRESH AIR
INTAKE AMOUNT [mg/st]
LARGE
SECOND TARGET FUEL
INJECTION AMOUNT [mg/st]
LARGE
SMALL
LOW
ENGINE ROTATION SPEED [rpm]
HIGH

FIG.10

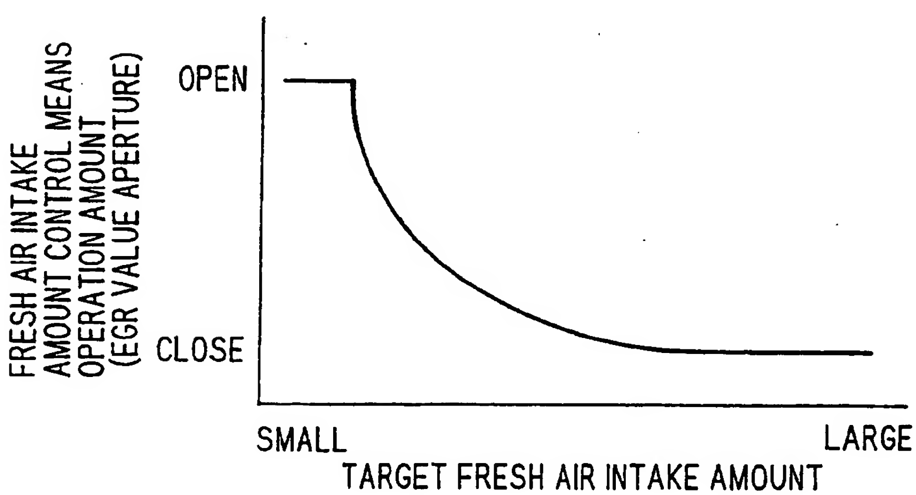

FRESH AIR INTAKE
AMOUNT CONTROL MEANS
OPERATION AMOUNT
(EGR VALUE APERTURE)
OPEN
CLOSE
SMALL
LARGE
TARGET FRESH AIR INTAKE AMOUNT

FIG. 12

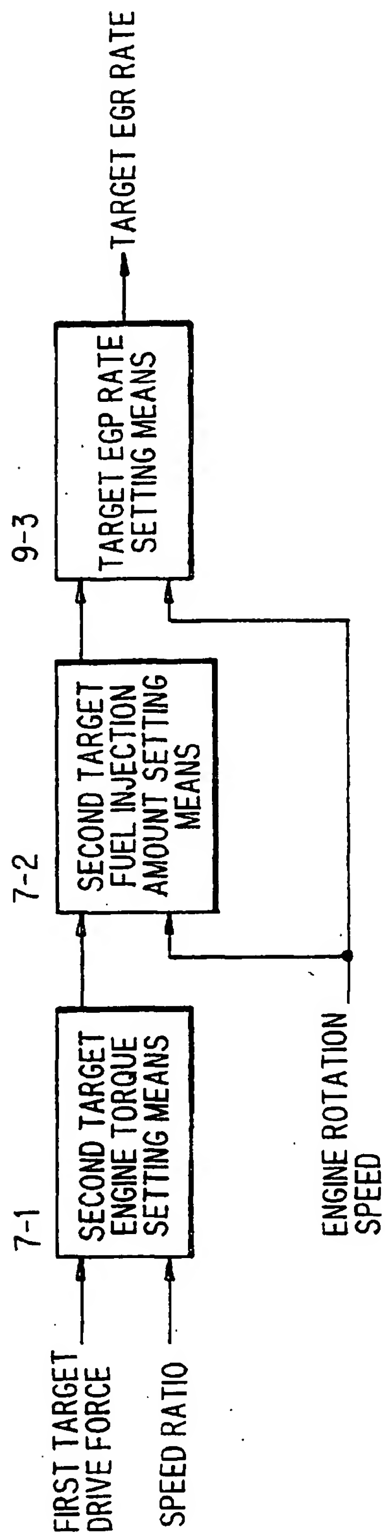

FIRST TARGET
DRIVE FORCE
SPEED RATIO
7-1
SECOND TARGET
ENGINE TORQUE
SETTING MEANS
7-2
SECOND TARGET
FUEL INJECTION
AMOUNT SETTING
MEANS
9-3
TARGET EGP RATE
SETTING MEANS
TARGET EGR RATE
ENGINE ROTATION
SPEED

FIG. 15

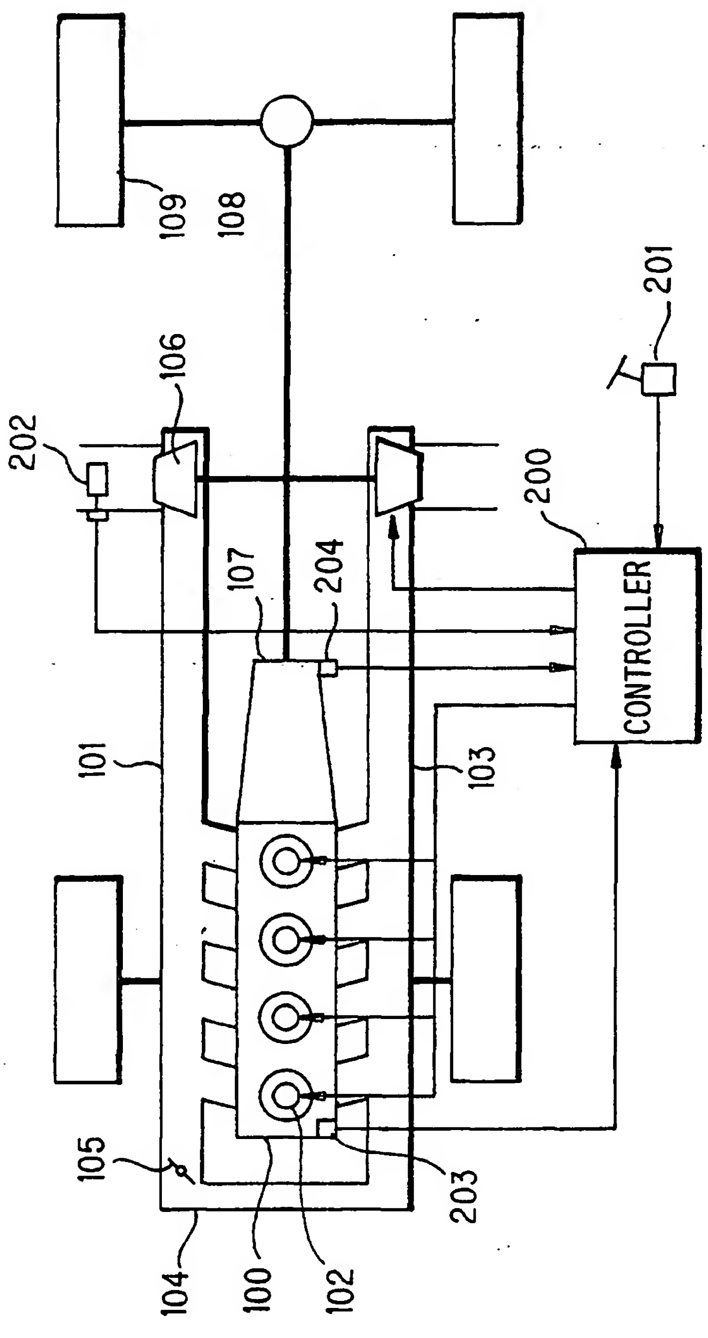

109
108
106
202
201
200
CONTROLLER
107
204
101
103
105
203
104
100
102

FIG. 17

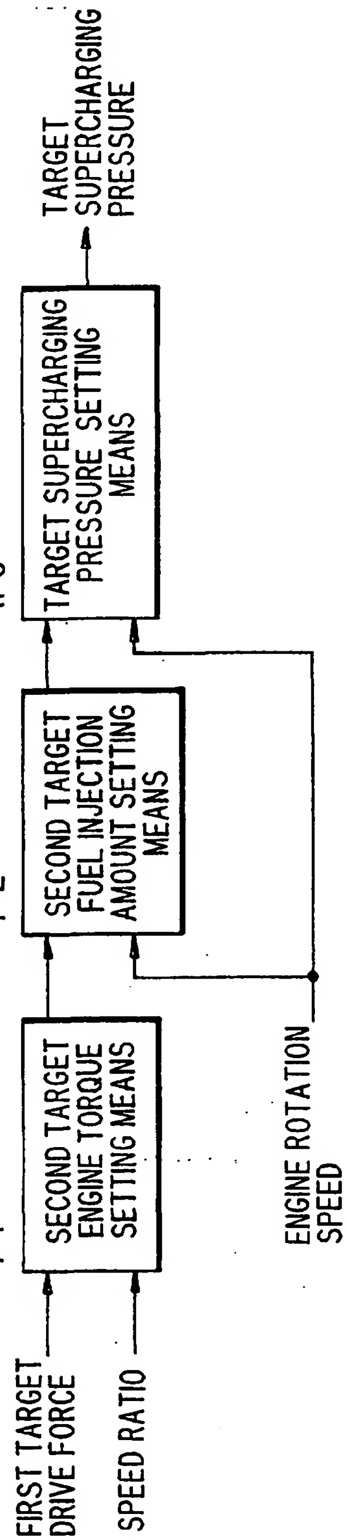
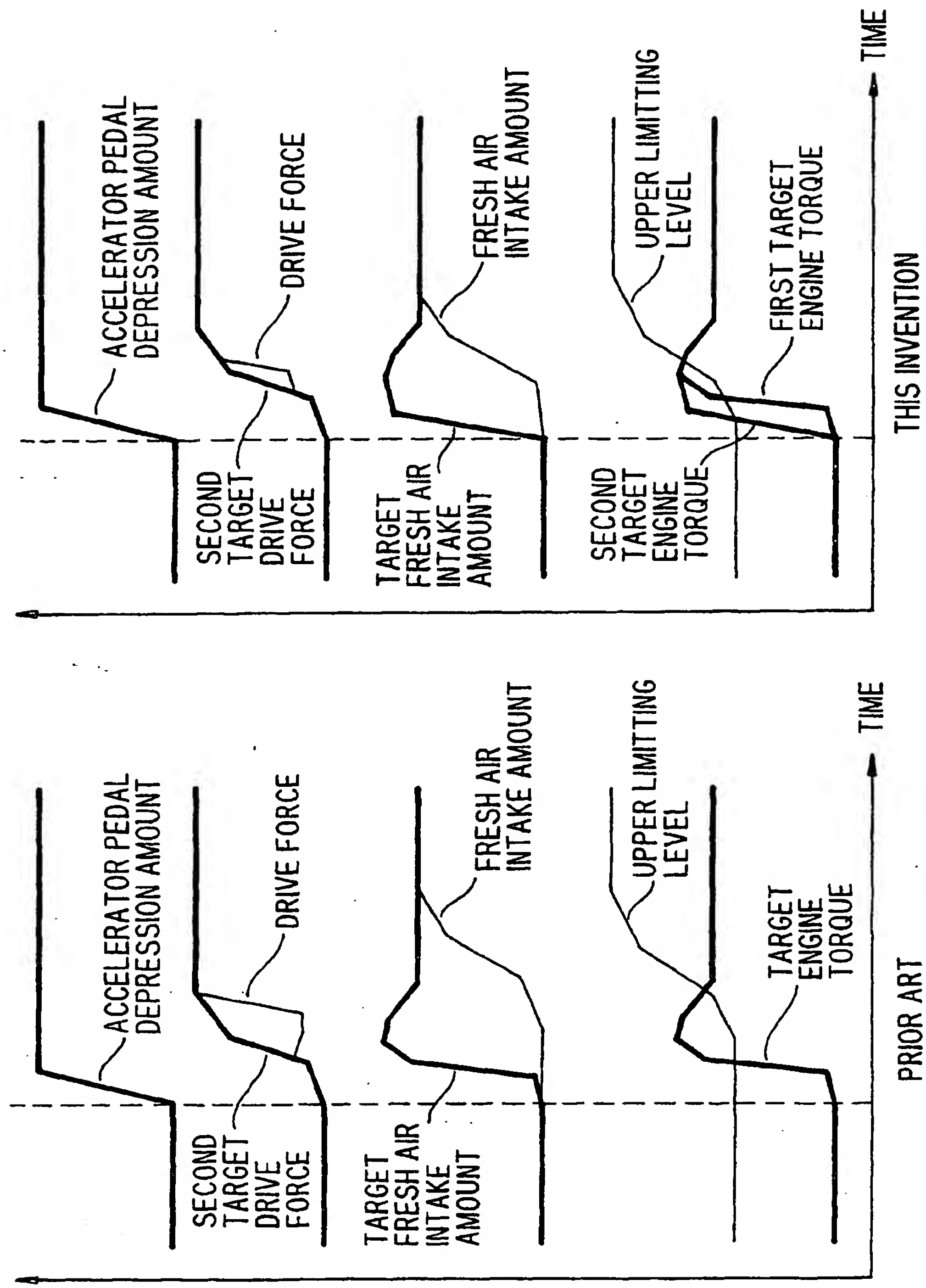

FIRST TARGET DRIVE FORCE
SPEED RATIO
7-1
SECOND TARGET ENGINE TORQUE SETTING MEANS
7-2
SECOND TARGET FUEL INJECTION AMOUNT SETTING MEANS
11-3
TARGET SUPERCHARGING PRESSURE SETTING MEANS
TARGET SUPERCHARGING PRESSURE
ENGINE ROTATION SPEED

FIG.20


ACCELERATOR PEDAL DEPRESSION AMOUNT
DRIVE FORCE
SECOND TARGET DRIVE FORCE
FRESH AIR INTAKE AMOUNT
TARGET FRESH AIR INTAKE AMOUNT
UPPER LIMITTING LEVEL
FIRST TARGET ENGINE TORQUE
SECOND TARGET ENGINE TORQUE
TIME
THIS INVENTION
ACCELERATOR PEDAL DEPRESSION AMOUNT
DRIVE FORCE
SECOND TARGET DRIVE FORCE
FRESH AIR INTAKE AMOUNT
TARGET FRESH AIR INTAKE AMOUNT
UPPER LIMITTING LEVEL
TARGET ENGINE TORQUE
TIME
PRIOR ART